Research Brief

Assessment of the Socrative Platform as an Interactive and Didactic Tool in the Performance Improvement of STEM University Students

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Abstract

This manuscript collects and analyzes students' academic results related to the change in teaching methodologies used in different subjects of different science and engineering university courses between 2013 and 2016 from traditional to active methodologies. Socrative, a platform that has been designed for the educational field, was introduced, allowing the use of personal mobile devices (laptops, smartphones, and tablets) consistent with the “Bring Your Own Device” methodology. The active methodology implemented allowed students to improve their academic results while learning and improving their passing rates.

Resumen

Este trabajo recopila y analiza los resultados académicos de estudiantes universitarios en relación a un cambio en las metodologías de enseñanza empleadas, llevadas a cabo en diferentes asignaturas y carreras de ciencia e ingeniería entre 2013 y 2016, pasando de metodologías tradicionales a metodologías activas. Se introdujo el uso de Socrative, una plataforma diseñada para el campo educativo, que permite el uso de dispositivos móviles personales (ordenadores, teléfonos inteligentes y tablets), consistente con la metodología "Bring Your Own Device". La metodología activa implementada permitió a los estudiantes mejorar sus resultados académicos, mientras aprenden y mejoran las tasas de aprobación.

Keywords: active learning, Bring Your Own Device, gamification, ICT, Socrative, STEM

Introduction and Literature Review

There is a growing trend toward a change in classical educational paradigms from traditional methodologies, centered on the teacher's expositions, to active methodologies in which the student has a greater participation. Some of the active methodologies that have gained popularity in recent years are based on the process of gamification and the use of information and communication technologies (ICT) in the classes. Active methodologies aim to be a contribution to the teaching processes resulting in an improvement in student learning. Basically, the term applied in the context of teaching refers to the use of techniques, elements and dynamics of games in order to enhance student's motivation as well as to reinforce their behavior to solve problems and promote the learning process (Deterding, Khaled, Nacke, & Dixon, 2011).

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A factor that may enhance performance in the classroom is the proliferation of mobile devices. A high percentage of students take their own smart devices to class, which allows them to use it in the development of class activities. Naismith, Sharples, Vavoula, and Lonsdale (2004) have already advanced the importance of the use of smartphones in classrooms. This use of the smartphones is exemplified in "Bring Your Own Device," which has become a very useful instructional strategy to promote an active commitment of students during learning (Nortcliffe & Middleton, 2013).

Most recent works advocate the implementation of active methodologies in classrooms. However, there are also studies, such as Burgan (2006), that defend traditional methodologies in education as the most appropriate, arguing that the passionate display of erudition is valuable in itself and that excellent lecture sessions raise questions in ways that inspire students to seek answers together.

There is a large amount of literature that reflects the positive impact of the application of active methodologies and gamification on the performance of university students, some of them focused on science, technology, engineering, and mathematics (STEM) disciplines as in this work; this is supported by the work of several researchers, including Freeman et al. (2014). Freeman et al. performed an interesting meta-analysis of 255 studies related to the change of performance of university students (STEM), in classes made with active methodologies compared to those taught with traditional methodologies, concluding that through active learning, the grades of students in all STEM disciplines increased, regardless of the size of the classes, types of courses, or levels at which they were taught. Other works in which an improvement of the performance of STEM university students has been reported with active methodologies include Freeman, Haak, and Wenderoth (2011); Freeman et al. (2007); Haak, Hillerislambers, Pitre, and Freeman (2011); Hamouda and Tarlochan (2015); Lorenzo, Crouch, and Mazur (2006); and Rodríguez-Oroz, Gómez-Espina, Pérez, and Truyol (2019). According to the literature review by Subhash and Cudney (2018), gamification provides several benefits for higher education students, such as improved student engagement, motivation, confidence, attitude, perceived learning, and performance.

There are also several studies that assess whether the nonattendance of higher education students correlates positively with a worse academic performance. Some of these studies maintain this positive correlation. Authors such as Romer (1993) have indicated that missing university classes in the United States has a large, negative impact on academic performance. A multitude of subsequent works (e.g., Cohn & Johnson, 2006; Credé, Roch, & Kieszczynka, 2010; Dobkin, Gil, & Marion, 2010; Gump, 2005; Halpern, 2007; Stanca, 2006), confirm these adverse effects of absenteeism. Arulampalam, Naylor, and Smith (2012) also observed this negative effect, but pointed out that missing classes has an adverse result mainly in the performance of the higher performing students over those students with low performance. On the other hand, there are also works that reject this direct relationship (e.g., Moore, Armstrong, & Pearson, 2008; Stoner & Fincham, 2012). According to Arulampalam et al. (2012), higher education students have greater autonomy in relation to their attendance to class. In view of the effect of absenteeism in classes, a greater attendance of students should be encouraged.

Socrative is an ICT that can be accessed through a web browser (see www.socrative.com) or through an application available for mobile devices. The platform is available in several languages and has both a free version, which was employed in this study, and a paid version that includes a greater number of options. In both cases, Socrative allows the teacher to create a database of tests of the subject, which can be done in class, that allow students to solve them through the browser in their computer or by means of the application for smartphones or tablets.

The teacher can present tests as a "Space Race," where the teacher's screen shows an interface in which individual students or teams are represented by an identifying color and a selectable icon (spaceship, bicycle, bee, etc.). These icons progress linearly as the questions are answered correctly (see Figure 1).

Figure 1. Image of the teacher's interface of Socrative during the development of a test in "Space Race" mode.

Thus, students compete in races that enliven the development of the test. When questions are answered, students have the option of receiving feedback about them (Figure 1. Image of the teacher's interface of Socrative during the development of a test in "Space Race" mode.

). The teacher then obtains a report with the results of the test.

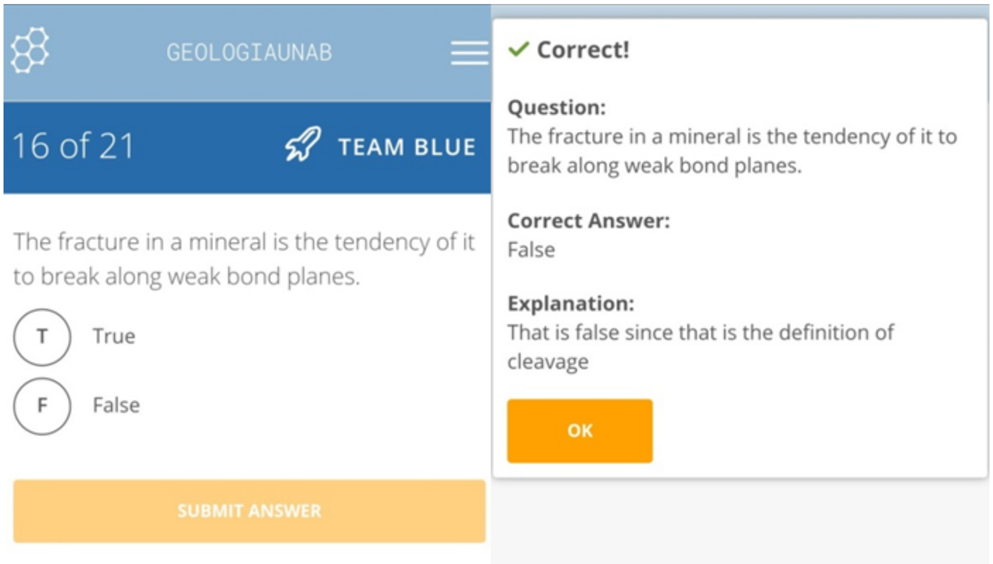

Figure 2. Example of true–false type question (left) in Socrative and feedback received by the student (right).

Some studies have evaluated the use of Socrative in classes. According to Sprague (2016), Socrative allows instructors to easily enhance their students' learning experience. Munusamy, Osman, Riaz, Ali, and Mraiche (2019) affirmed that Socrative, as a supplement in a lecture, enhances understanding of the material and allows students to be an active participant in the classroom setting. Other researchers—such as Frías, Arce, and Flores-Morales (2016); Guarascio, Nemecek, and Zimmerman (2017); and Chou, Chang, and Lin (2017)—support the use of this tool.

The present work compares traditional approaches and active approaches based on ICT and gamification in a number of subjects taught in majors related to earth sciences and engineering. Researchers such as Subhash and Cudney (2018) have noted a lack of research on gamified learning in engineering disciplines. We tested the hypothesis that students using active approaches based on ICT would earn higher exam scores.

The present study also evaluated the effect of using active methodologies on students' class attendance. Absenteeism in classes is of important consideration, because it conditions the performance of the student in the subject (Romer, 1993). Active learning could help to improve the students' class attendance (Yuretich, Khan, Leckie, & Clement; 2001). The purpose of the study was to determine whether these active approaches improved class attendance, because attendance is considered an important factor in their performance in the subject, and if they increased average grades.

Method

The present study is based on the academic results of first- to fourth-year higher education students obtained between 2013 and 2016. Academic subjects were related to the area of geology and were taught in both science and engineering majors. The same teacher taught the subjects during successive years. This allowed us to analyze the influence of the methodology while holding teacher influences constant. The details of these subjects are shown in Table 1.

Table 1. *Subjects, Majors, and Courses Involved in the Study*

Subject	Major	Course
Mineralogy	Geology	2nd
Genesis of ore deposits	Geology	4th
General and structural geology	Mining engineering	1st
Petrology and mineralogy	Mining engineering	2nd
General geology	Civil engineering	2nd

Initially, the traditional methodology based on the teacher's lecture was the method used to teach the classes. The active methodology developed was based on the incorporation of the Socrative platform in classes. At the end of the classes, students answered a test launched through Socrative. The Socrative tests were carried out in at least 83% of the classes of each subject and lasted approximately 40 min, while the total duration of the classes was 2.5 hr. To fill out the tests, students were allowed to review their notes, search the Internet, and even cooperate with their peers, fostering a relaxed and dynamic environment in a process of gamification. Students did not receive any kind of bonus for participating. The passed percentages, exam grades, and absenteeism were analyzed in each condition.

Statistical Analysis

A series of midterm exams was carried out during the course (either two or three, depending on the subject) and there was a final exam. The exams were averaged to obtain the final grade. The final exam weighed 30% of the final grade. The evaluation methodology used was the same for both the traditional methodology and the active methodology. Course grades in this country range from 1.0 and 7.0, with the minimum passing grade being 4.0.

Some students completed evaluations of the Socrative platform. These surveys were intended to assess the usefulness of the platform in learning and the effect on student motivation by answering the following questions: (a) Was the use of Socrative in class useful for your learning? and (b) Did you feel motivated by the use of Socrative in class? Responses ranged from 1.0 (*not useful* or *not motivating*) to 5.0 (*very useful* or *very motivating*). In addition, the same surveys collected comments on the pros and cons of the ICT platform used.

Results

Table 2 compiles a series of demographic and academic data by methodology used, such as distribution of the number of students by gender, registered absences, percentage of students with passing grades and average final.

Table 2. *Demographic and Academic Data According per Methodology*

Methodology	Women	Men	Absence	Pass	Average final grade[a]
Traditional	67	158	21%	46%	3.7
Socrative	61	132	12%	59%	4.0

[a] The minimum grade is 1.0 and the maximum is 7.0. The passing grade corresponds to a 4.0.

In general, the number of students enrolled in the subjects is quite variable, ranging from two to 70 in the different courses taught. The relationship between the number of male and female students is close to 50% in the subjects of the geology degree, while in engineering majors the percentage of female students is much lower, with figures in some subject of only 20% of the total. Overall, the percentage of women is 31%.

The pass rate was 13 percentage points higher than for those in the traditional classrooms. The average score for midterm grades was 3.7 in the Socrative classroom compared with 3.4 in the traditional classroom; for final grades, it was 4.0 and 3.7, respectively. The final grades of each student according to their gender and applied teaching methodology reveal an improvement in both cases with the methodology based on Socrative, more notable in the case of women. Women increased from 3.5 with the traditional methodology to 4.2 with the use of the Socrative platform, whereas men increased from 3.8 to 4.0.

To determine if the differences in the grades were statistically significant, a student's *t* test was performed according to the Kolmogorov–Smirnov methodology. From this analysis it was determined that the scores do not follow normal distributions, so it was not possible to make the comparison between both populations of grades with this methodology. Due to this, it was decided to perform a nonparametric analysis corresponding to the Mann–Whitney *U* test. The results confirm that the grades according to the Socrative based methodology are higher and different than those obtained with the traditional method, $z = -3.883$, $p < .05$. Thus, the null hypothesis was rejected. Finally, during the years in which the subject was taught with active methodology, absenteeism was reduced to almost half.

Perception of the students of the Socrative Platform

The results of these surveys collected from 72 students indicate good acceptance of the tool. Students value the Socrative platform positively, both because it is a tool they consider motivating (giving 4.3 points out of 5.0) and because of its usefulness in learning the subject (giving 4.5 points out of 5.0). Some of the pros and cons about the use of the Socrative platform according to the students are summarized below.

Different comments collected among the students evaluating the platform point that the most outstanding advantages of the use of Socrative are, on the one hand, the way in which the tests are described as very pleasant. On the other hand, they emphasize the usefulness of immediate feedback allowed by the platform. Additionally, students indicated that the reinforcement of learning fostered a better understanding of the subject. One of the disadvantages was that completion of the Socrative tests is carried out at the end of classes when they are tired and their concentration has decreased.

Discussion

The inclusion of an active methodology based on Socrative in classes is an important change. An increase of the final grades has been observed in the years using this active methodology in relation to the former with traditional methodology. The average grade of the midterm exams improved as well as the final grade after the application of the active methodology. Altaany and Alsoudani (2015) and Lim (2017) found in their research as well improvement in the performance of university students with the use of Socrative.

The average final grades showed more improvement with the active methodology in relation to the traditional one, more notable in the case of women. Lorenzo et al. (2006) observed the existence of an unfavorable gender gap for women in the results of their physics students at Harvard University. In their work, they demonstrated that the use of active methodologies reduces and even eliminates the difference in performance between male and female students. Pollock, Finkelstein, and Kost (2007) replicated the Lorenzo et al. study and found that active methodologies not only neglected to reduce the gap but sometimes expanded it; they concluded that variables related to students and instructors have a greater effect on the gender gap than did the active technology. Our results show that the active methodology had a different impact depending on the gender.

Based on the results of our implementation, we can state that the use of this active methodology based on ICT and gamification affects students' grades positively compared to those obtained with a traditional methodology. Absenteeism with the active methodology is notably reduced. Other works have also reported an improvement in class attendance by applying active methodologies based on ICT, such as Fies and Marshall (2006) and Lewis, Chen, and Relan (2018). On the other hand, Lim (2017) showed that the use of Socrative in the classes does not improve attendance of the students. The decrease in absenteeism could be justified due to greater student motivation to attend more dynamic, stimulating classes and the possibility of obtaining an immediate feedback, which in turn would positively influence their academic performance. Several authors have favorably linked motivation with academic results, such as performance and persistence (Çakıroğlu, Başıbüyük, Güler, Atabay, & Yılmaz, 2017; Ryan & Deci, 2000; Taylor et al., 2014; Walters, Potetz, & Fedesco, 2017).

Our results demonstrate that Socrative has good acceptance among students. These observations match those made by students in other works. Lim (2017) found the majority of students pointed to an improvement in their focus in class and their link with the instructor, which greatly improved their learning experience. In the surveys conducted by Badia, Olmo, and Navarro (2016) among their students, they appreciated the ease of use of the application, regardless of the device (computer, tablet, or mobile phone). They also point out that most students believe that the use of Socrative is positive and useful to acquire the competence of understanding and integrating into the subject. Frías et al. (2016) and Guarascio et al. (2017) highlighted the good acceptance of students of this type of teaching modality. Gámiz-Sánchez (2017) asserted that both students and teachers expressed a positive attitude toward the active use of ICT as support for their teaching and learning experiences.

In this study, the effect of gamification on motivation was evaluated in the group of students and not individually. One of the main limitations of this type of study is the lack of theoretical foundations to explain the motivational effects (Seaborn & Fels, 2015). According to Sailer, Hense, Mayr, and Mandl (2017), it is necessary to apply the psychological theories of motivation to determine how gamification affects motivation.

Conclusion

We found the reception by students of the Socrative platform to be very positive; they reported finding this tool useful for their learning and very motivating as well. The use of Socrative has led to an improvement in academic performance compared to traditional methodologies, resulting in an increase in the percentage of passing and average final grades. Thus, our analysis substantiates the benefits of using active technologies in the classroom and specifically in STEM training programs.

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